

On the Asteroidea and Echinoidea of the Korean Seas.

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(PLATE VIII.)

THE Echinoderms collected by Capt. St. John whilst surveying in the Straits of the Korea and neighbouring Japanese waters, were intrusted by Dr. J. Gwyn Jeffreys and Dr. Günther to Prof. P. Martin Duncan, to whose kindness in placing the material in my hands I owe the pleasure of presenting the following communication upon the small but very interesting series of Asteroidea and Echinoidea. It is only justice due to Capt. St. John to remark that the value of the present collection is enhanced by his very careful registration of the exact position and depth at which the specimens were taken; whilst the importance of the Echinoderms themselves is increased by the fact that many of them belong to forms hitherto little known or imperfectly described; in addition to which several are represented by small and premature growth-stages, which enable us to fill in phases in the life-history of the species to which they belong. The association of several of the species will also be found full of particular interest.

Holding the opinion that the duty of a naturalist is not completed by the simple determination of mere lists of species from a given locality, but rather that it lies in pointing out what variations are undergone by known "forms" from the general type in order to attest the results of the conditions of the special habitat, it has been the aim of the author to indicate as far as he was able the particular modifications presented in the cases under notice, or at least to denote the grounds on which the determinations rest.

ASTEROIDEA.

ASTROPECTEN FORMOSUS, sp. nov. Pl. VIII. figs. 1, 2, 3, 4.

Coll. St. John: Korea, 36 and 54 fathoms (young); W. Coast of Nipon, 60 fathoms.

Disk large, rays short, arm-angles widely rounded; the greater and lesser radii of the largest specimen measure respectively 14.5 millims. and 5.2 millims., or in the proportion of $2\frac{3}{4}$:1 approximately. The foot-papillæ, which are all cylindrical and taper towards the tip, form two series: the inner one, which spreads

out into a comb overhanging the ambulacral furrow, is composed of three papillæ, the middle one being longer than the others; the outer series, which radiates towards the ventral plates, consists in the middle of the arm of three papillæ, whilst along the inner fourth of the furrow there are four or five, these being arranged two and two, or two and three together, one pair opposed to the inner series, the others placed more external and nearer together. On the innermost plates of the ray this external series of foot-papillæ is further augmented by two or three additional spinelets, and which form an almost imperceptible transition into the scuticles of the ventral plates. The ventral marginal plates bear three spines—the uppermost, or that nearest the margin, being the smallest; the second is large, compressed and acuminate, twice the size of the marginal spine, and is succeeded by another almost as large. The spines are arranged obliquely across the plate, except in the arm-angle, where they form a straight series along with two or three additional spinelets which lie between them and the furrow. The main spines of these inmost plates of the arm-angle are also somewhat smaller than their successors. The rest of the ventral plate is covered with numerous small compressed and finely acuminate scuticles, standing erect and fairly well spaced, which present quite a different appearance to the flat, closely-packed, spatulate scales which so frequently clothe the under surface of *Astropecten*. The furrows between the plates are wide, having the margins set with fine setæform spinules, very different from the armature of the plate just described. The upper marginal plates, which are broader than long, number about sixteen on each side, exclusive of the tip. They are closely papillate; and the spine-like papillæ are cylindrical, with radiate tips more or less expanded and quite clavate. There are about five rows of these spinelets upon a plate, exclusive of the marginal setæform series, the middle ranges being larger than the rest; whilst the setæform spinelets which fringe the furrows are much longer and more delicate, and present in a more marked degree the clavate character of the tip.

The paxillary area is, at the middle of the ray, a little broader than the marginal plate (though not twice as broad); and the paxillæ are large and very distinctly stellate, 5-6-radial, with a ray springing from the centre as well, though sometimes this is wanting. The madreporiform body is situated close to the marginal plates.

Two very young *Astropectens*, measuring respectively 10·5 millims. and 8 millims. in their greatest diameters, seem to belong to this species. The relative characters of the disk and rays, the arrangement of the foot-papillæ, the armature of the ventro-marginal plates, and the paxillæ of the dorsal surface present only such differences as might be expected in the premature conditions of the *Astropecten* above described. The inner row of foot-papillæ consists of three spinules as in the adult form; but in the outer series there are only two on the outer portion of the furrow, and three on the inner; their arrangement, however, being such as to leave little doubt, when comparison is made with the different portions of the furrow in the largest specimen, that they belong to one and the same species. On the marginal plates of the smaller specimen there is only one spine; but on the larger there seems indications here and there of the future development, out of the plate armature, of the larger companion spines. The paxillæ are large and much simpler than in the adult, having fewer radii.

Although these juveniles were dredged on different occasions—one being taken off the Korea at the depth of 54 fathoms, and the other off W. coast of Nippon, 60 fathoms—they both agree in the singular circumstance of having gorged a small bivalve! and in each case apparently of the same species. In the larger of the two young starfish the distention of the test and the position of the shell lead to the supposition that the diminutive *gourmand* had fallen a martyr to the indulgence of its appetite!

This *Astropecten* bears some resemblance to certain examples of the northern form known as *Astr. Mülleri*, M. & T.; regarding that, however, as an extreme variation of *A. irregularis*, the differences presented by the Asteroids at present under consideration are such as to justify the opinion that they should be classed (provisionally at any rate) as distinct from that species. It would not, however, be surprising to find, from the examination of a larger supply of material from this and other localities than is at present available, that the above specific determination would require to be included within the *extended* diagnosis of the type of *A. irregularis*, although the distribution as at present known of the varietal forms of that species (e. g. *A. Mülleri*, *A. echinulatus*, etc.) would hardly lead to such a supposition.

ASTROPECTEN JAPONICUS, *Müller & Troschel*.

1842. *Astropecten japonicus*, *Müller & Troschel, System der Asteriden*, p. 73.

Coll. St. John: Korean Straits, 9 fathoms.

The arms are moderately long and narrow; $R=11.25$ millims., $r=4$ millims. The foot-papillæ, arranged in wedge-shaped groups of five, are long, fine, and cylindrical. The first spinelet, which forms the apex of the wedge, stands by itself, projecting inward upon the furrow, is thicker than the rest and arched upwards at its base; the others stand external to this, two and two together, the outermost pair being rather longer than the inner pair; whilst on the inmost portion of the furrow the outer series of papillæ are augmented by one or two additional spinelets. The adambulacral plates which bear the foot-papillæ appear very much depressed, in consequence of the gibbous character of the ventro-marginal plates—a feature which is very striking when compared, for instance, with specimens of *Astr. formosus*, mihi, of nearly equal size.

The upper marginal plates are broader than long, and covered closely with short stout granulose spinules of clavate form, and on the outer half of the arm carry on their outer margin a small conical spinelet. In the specimen under notice the nine outer, out of thirteen marginal plates, are thus armed.

The ventro-marginal plates project more outwardly than the upper marginal plates, and bear one large, compressed, lanceolate spine at the margin, which is generally followed by two smaller spines placed side by side, not half its length, and very much finer and more cylindrical. The rest of the spinulation consists of small, short, isolated, cylindrical spinelets. In the present example these have been very much abraded; and little further detail can be made out.

The dorsal area or paxillary field is, in the middle of the arm, very little, if any, broader than the marginal plate. The paxillæ are large and closely crowded—so much so that the radii (of which there are 8–9 and very robust) of a paxilla are directed upward, instead of at right angles to their pedicle; and this gives to the paxillary area a granulate rather than a stellate appearance to the naked eye, and without any indication of regular arrangement.

Dr. Lütken remarks* on never having seen an *Astr. japonicus*

* 'Videnskabelige Meddelelser' for 1864, p. 127.

with the spines upon the dorsal marginal plates. On the specimen under consideration these are so small that they might easily be passed over without notice,—whilst, further, it is a character of such usual variability that I am fully prepared to believe in the existence of examples in which they are wanting altogether, their rudimentary state on the present specimen quite leading to that idea. A seemingly parallel instance may be pointed to in the case of *Astr. euryacanthus*, Ltk.*; in the premature stages of which small spines are present on the outer margin of the dorsal marginal plates towards the ends of the arms, but no trace of them remains in the adult†.

Our knowledge of this species at present is very scanty; and it may not be beyond the range of probability that a more extensive series of specimens will require the modification of our current ideas of the form altogether, and possibly even its amalgamation with such a species as *A. scoparius*, when more is definitely known about the premature stages of these *Astropectens*.

ASTROPECTEN POLYACANTHUS (of *A. armatus*-type), *M. & T.*

1842. *Astropecten polyacanthus*, Müller & Troschel, *System der Asteroidea*, p. 69, taf. v. fig. 3.

— *Astropecten hystrix* (Val. MS.), *M. & T. ibid.* p. 70.

— *Astropecten armatus*, Müller & Troschel, *ibid.* p. 71.

1843. *Astropecten vappa*, Müller & Troschel, *Wiegmann's Archiv f. Naturgesch.* Jahrg. 9, p. 119.

1864. *Astropecten armatus*, Lütken, *Vidensk. Meddelelser for 1864*, p. 132.

1865. *Astropecten armatus*, v. Martens, *Ueb. Ostasiat. Echin.*, *Wiegmann's Archiv*, Jahrg. 31, p. 352.

1876. *Astropecten polyacanthus*, Perrier, *Stell. du Mus., Arch. de Zoologie gén. et expér.* t. v. p. 275.

Coll. St. John: Yedo Bay.

So far back as 1864, Dr. Lütken † raised the question as to the validity of the separation of *A. armatus*, M. & T., from Japan, and *A. vappa*, M. & T., from Australia, as species distinct from the typical form of *A. polyacanthus* from the Red Sea, asserting his inability to detect in the material he had examined any characters of specific value to warrant such a division. M. Perrier, after

* Vidensk. Meddel. 1871, p. 232.

† Compare with this Lütken's remarks on a specimen of *Astr. aster* wanting the spines (in Vidensk. Meddel. 1864, p. 130).

‡ "Kritiske Bemærkninger om forskjellige Söstjerner," Vidensk. Meddel. 1864, p. 132.

studying the large collections in Paris, concurs in these views, and maintains the consolidation of the above-mentioned forms, including also *A. hystrix* (Val.), M. & T.*

M. Perrier further expresses his opinion that the differences upon which the separation has stood are nothing more than conditions of age and locality—the series of specimens which the French *savant* has had the opportunity of examining being procured from stations as widely distant as Zanzibar, Muscat, Ceylon, Hong-Kong, Fiji Islands, Port Jackson and several other localities in Australia, thus indicating a very extensive distribution of the *A. polyacanthus* type.

Although the present specimen is in a somewhat weathered condition, it can unmistakably be assigned to the varietal group formerly described under the name of *A. armatus*, M. & T. In each ray the three marginal plates which succeed to the innermost in the arm-angle are destitute of tubercles and dorsal marginal spines. This character is regular, and accords with the typical description given in the 'System der Asteriden.' Lütken (Vidensk. Medd., 1864, p. 132) chronicles the occurrence of considerable irregularity and variation in the number of these spineless plates in different rays of the same individual, and cites examples from Hong-Kong having only one, or two, or even none of the undeveloped spineless plates on different rays of the same specimen. This starfish measures $R=35$ millims., $r=9.6$ millims.

Without calling in question the accuracy of M. Perrier's determination, the occurrence of such instances as this of a form presenting strongly marked variations at different stations within the area of its distribution, urges upon naturalists the necessity of exercising extreme caution against being led away by a tendency to group too comprehensively the forms which may be included within a large and widely distributed genus; for however seriously the multiplication of frivolous "species" may embarrass a classification, the wholesale grouping, or, in other words, the unbounded extension of the limits of specific character, is productive of much more injurious results, in that it curtails the precision of definition, and, whilst ignoring environment as a factor, divests nomenclature of one of its highest and most important qualities.

* "Stellérides du Muséum," Archives de Zoologie expérimentale et générale (Lacaze-Duthiers), tome v. 1876, p. 275.

From the fact that forms are separated by much smaller and less striking differences in an extensive genus than in one of more limited scope, "species" in the larger group have often not such clearly marked or conspicuous characters as those which are presented by "varieties" in a less comprehensive genus. It follows that the judgment should be very cautiously exercised when tempted to embrace within a single species all the strongly marked distributional extremes of any widely-spread type, however closely their connexion may seem to be preserved through intermediate forms; for in many cases these gradations are nothing more or less than the links which indicate to us the development of "species," and are, in short, the stages with which generally we are unacquainted, owing either to the imperfection of knowledge, or more frequently by reason of their destruction through the hostility of unfavourable conditions.

Taking into consideration the advance which knowledge is continually making by means of the addition of new material from hitherto unexplored fields, the process of too comprehensive grouping would ultimately result in the formation of series which, from their very unwieldiness, would require arbitrary division for the mere purposes of classification and comprehension, if the ordinary natural distinctions be ignored. Of course it will be acknowledged that "species" are but arbitrary divisions after all, and that a *nomen triviale* serves but to register the state of information and our opinions upon certain forms of life; but since under such an aspect the organisms themselves stand as the outcome of adaptation and the conditions of existence, the latter factor being thus synonymous with *habitat* or geographical position, taken in its widest sense, it would evidently be a disadvantage to science to lose the record of the influence which has been exerted, and to sacrifice so simple an indication of the relative position of a modified type within the area of its general occurrence.

STELLASTER BELCHERI, *Gray*.

1847. *Stellaster Belcheri*, *Gray, Proc. Zool. Soc.* 1847, p. 76; *et Synopsis of Starf. Brit. Mus.* (1866), p. 7, t. vii. fig. 1.
 1866. *Goniaster (Stellaster) Belcheri*, *von Martens, Ueb. Ostasiat. Echin., Wiegmanns Archiv*, Jahrg. 32, p. 86.
 1871. *Goniaster (Stellaster) Belcheri*, *Lütken, Vidensk. Meddelelser for* 1871, p. 247, tab. v. fig. 3.

1876. *Pentagonaster* (*Stellaster*) *Belcheri*, *Perrier*, *Stellérides du Muséum*, *Arch. de Zool. expér. et gén.* t. v. p. 42.

Coll. St. John : Korean Straits, 50 fathoms.

In the type specimen figured and described by Dr. Gray, a group of two or three small tubercles is situated upon the disk in each radial area at about the same distance from the centre as the madreporiform body, whilst further outward, at the base of the arm, stands a single isolated tubercle, likewise in the median line of the ray.

In an example of *S. Belcheri* from Australia, which Dr. Lütken has described, this latter tubercle is wanting; and from the circumstance of the specimen being much smaller than that of Gray's (measuring only $r=8$ millims., $R=25$ millims.), Lütken has been led to regard the presence of this isolated tubercle at the base of the rays as merely a dependence on age and growth.

The present specimen is smaller than either of the above, and is interesting from the fact that the only tubercles which it possesses are a single one in each radial field. Each of these occupies the middle of a plate which is situated rather further than the madreporiform body from the centre of the disk, and is surrounded by several small granules markedly larger than those which cover the plates generally. The disk is moderately convex, the radial areas gibbous, and the interradianal ones depressed. The semidiameters of the disk and rays measure 7 millims. and 19 millims. respectively.

The inner row of foot-papillæ form a compact comb on each interambulacral plate, arching upward over the furrow and having in each group 5-6 papillæ, the ad- and aboral being smaller than the others. The outer series consists of a single small, short, stout papilla placed opposite to the middle of the inner row, and having two or three papillate granules on each side, sometimes in line and sometimes behind it, the whole forming a more or less regular line parallel with the inner series. Occasionally a few additional granules form an irregular reduplication of this series, whilst upon the inner portion of the furrow the granules which stand near to the main single papilla gradually increase in size, the distinction between them becoming almost imperceptible. There are but few *pedicellariæ valvulatæ* on the dorsal surface, and none on the marginal plates. The marginal spines are compressed, not tapering towards the tip, which is rounded. Upon the two outer thirds of the arm there is only a single plate in the dorsal

area between the marginal plates, the last two or three of which meet in part of their length, and thus disconnect the median series.

CRIBRELLA DENSISPINA, sp. nov. Pl. VIII. figs. 5, 6, 7, 8, 9.

Coll. St. John: Korean Straits, W. coast of Nippon, 40 fathoms.

Arms rounded and very uniform in thickness throughout their length, tapering only slightly and very gradually towards the extremity, which is blunt and well rounded. Arms slightly flattened at the base, and quite continuous with the disk, being separated by no interradiation depression; arm-angles well rounded. The ossicles of the rays and disk are covered very densely with small closely-crowded spinelets, so closely packed as to suggest to the naked eye the granulate appearance of *Linckia*. The spinelets are built-up of multiradiation laminæ, and by expansion at the tip assume a clavate form. The intermedial pore-arms are very small, quite disconnected and enclosed; they are frequently furnished with one papilla only; but two or occasionally even three occur.

The madreporiform body is nearer to the centre than the margin of the disk; and the septa, which radiate in straight lines from its centre, are closely studded with spinelets similar to those of the disk and rays.

The foot-papillæ are more robust than the spinelets of the dorsal or lateral portions of the ray, and are placed in oblique pairs upon the adambulacral plates. The inmost pair, or that nearest the furrow, are longer and much stouter than the others, and are succeeded by four or five similarly oblique pairs of smaller spinelets, following in series and gradually diminishing in size and thickness until they merge imperceptibly into the densely packed spination of the ventro-lateral plates.

The specimen measures $R=25$ millims., $r=5$ millims.; breadth of a ray midway between the tip and disk, 4 millims.

ASTERACANTHION RUBENS (*Linné*), var. *MIGRATUM*, *mihi*.

Coll. St. John: Korean Straits.

Two small specimens, their greatest radius measuring 16 millims. and 12 millims. respectively. Although only in a young and premature stage of growth, I feel little hesitancy in assigning these starfish to the above widely spread species.

The ambulacral papillæ are short, moderately stout, and cylindrical, and arranged two and one alternately upon the interam-

bulacral plates, with more or less regularity according to the individual, sometimes the odd spines being few and far between. These are succeeded by the ventro-lateral spines in oblique rows of two (or three in the middle portion of the arm), and are stout, moderately long, and slightly tapering towards the tip; then follows the broad side-area, bounded by the lateral spines, which are similar in size and character to the last mentioned, and, standing one to a plate, are well spaced and form a straight marginal series. These spines are surrounded at the base by a thin circlet of small *pedicellariæ forcipiformes**; and the ventro-lateral series have also a few on their upperside. The spines of the dorsal surface are small, tapering towards the tip, and pointed; they are widely spaced and have a few *pedicellariæ forcipiformes* at their base, but no wreath (and in some cases only two or three even), whilst the interspace between the spines is very thickly strewn with numerous large *pedicellariæ forcipiformes*.

The large size and great number of these latter *pedicellariæ*, as well as the isolated character of the marginal spines, without even a trace of any undeveloped companion such as is frequently to be found in young *A. rubens* of typical form at the same age, the general absence of all embryonic secondary spines on the intercalary pieces, either of the dorsal surface or the sides, and, in

* In 1866, Dr. W. B. Herapath published a memoir "On the *Pedicellariæ* of the Echinodermata" (Quart. Journ. Microscop. Science, vol. v. pp. 175-184), in which he described the structure of these organs as presented in the Asteriadae, at the same time assigning very characteristic technical designations to the different forms. This paper, unfortunately, seems to have been overlooked by subsequent writers, and also by M. Perrier, who in 1869 brought out his careful and very excellent 'Recherches sur les *Pédicellaires* et les *Ambulacres* des *Astéries* et des *Oursins*.'

Apart, however, from Dr. Herapath's obvious claim to priority, certain of the names employed by the French *savant* can only be regarded as colloquial terms which would require to be replaced by a more strictly scientific nomenclature before they could become the general property of the naturalists of other countries. It is therefore with particular pleasure that attention is called to the above-mentioned earlier paper, as it supplied the want in the direction indicated.

According to Dr. Herapath's terminology, the *pedicellariæ forcipiformes*, or "scissor-shaped," are equivalent to the "*pédicellaires croisés*" of M. Perrier; and the *pedicellariæ forcipiformes*, or "shears-shaped," to the "*pédicellaires droits*" of the French author. The terms being synonymous with the "major" and "minor," the "large" and the "small," as applied to *pedicellariæ* by some American and English naturalists.

fact, the *tout ensemble* of the spinulation, dispose me, after careful study of this limited material, to regard the starfish as presenting a well-marked locational variety of the *A. rubens* type. And although these structural modifications are not such as would command more special recognition, the divergence seems one which is well worthy of record in a morphological point of view.

ECHINOIDEA.

STRONGYLOCENTROTUS INTERMEDIUS (*Barnes*), *A. Agassiz*.

1863. *Psammechinus intermedius*, *Barnes*, in *A. Agassiz*, *Proc. Acad. N. S. Philadel.* p. 357.

1866. *Boletia radiata*, *von Martens*, *Ostasiat. Echin.*, *Wieg. Archiv*, Jahrg. 32, p. 136.

1872. *Strongylocentrotus intermedius*, *A. Agassiz*, *Rev. Echini*, *Ill. Cat. M. C. Z.* p. 164.

Toxopneustes grandiporus, *Lütken* (*MS. Copenhagen Mus.*), *vide A. Agassiz*.

Coll. St. John : lat. 34° 8' N., long. 126° 24' E., Korean Straits, 24 fathoms.

Owing to its dense clothing of short moderately uniform spines, this Echinoid bears a great resemblance in facies to *Sphærechinus*. The resemblance, however, is merely superficial, as neither the tubercles nor the spines are equal-sized, nor are the former closely packed upon the plates or arranged in strictly horizontal rows; the gill-slits are very slight, being little, if at all, more deeply indented than generally in *Strongylocentrotus*. In none of the above-mentioned details, which are regarded as stable generic characters in *Sphærechinus*, does the present sea-urchin agree; and although it resembles that genus in possessing only four pairs of pores to each arc, their mode of arrangement does not differ essentially from that of *Strongylocentrotus*.

The poriferous zones are nearly as broad as the median ambulacral area, which at the ambitus bears four vertical ranges of tubercles—the outer ones, which stand next to the poriferous zones, being much larger than the inner series. On the interambulacral plates there are three primary tubercles, the middle one longest; and this alone remains prominent up to the apical disk, whilst the companion tubercles diminish very rapidly on the abactinal surface, being wanting altogether or represented only by small miliaries on the uppermost plates. There are also two or three large secondaries and a moderate sprinkling of miliaries

upon the plates, but which diminish both in size and number on the upper portion of the abactinal surface; two of the secondaries are placed on the aboral margin of the plate, and stand above the interspaces between the primary tubercles. There are also two or three small tubercles between the arcs in the poriferous zones, the one which stands under the upper pore of each ambulacral plate (*i. e.* the second pore of an arc) being nearly as large as a primary tubercle; and its series forms a prominent vertical row. The genital plates are comparatively small, with the exception of the madreporite, and the oculars large, two of them entering the anal circle; both the ocular and ovarial orifices are conspicuous.

The actinostome is small, the indentations well marked but not deep, and the buccal membrane furnished with small elongate calcareous plates.

The colour of the test is light purple or greenish, having the interradii frequently of a darker tint; and that of the spines dark olive tipped with purple. In one small specimen the spines of the ambulacra are greyish white tipped with violet. The specimens dredged by Capt. St. John accord closely with the description given by Von Martens of *Boletia radiata*, which Mr. Alex. Agassiz indicates, from personal knowledge, to be synonymous with Barnes's earlier determination of *Psammechinus intermedius*. Hence the present reference of the Echini under consideration.

ECHINOMETRA LUCUNTER (*Leske*), *Blainville*.

Coll. St. John: Hatzura, Japan.

Only one small premature specimen, which seems to vary from the ordinary Pacific form in its shorter and stouter spines, and prominent and somewhat exposed apical disk. *E. lucunter*, however, is such a highly variable form, and the changes which take place during growth are so great in all the members of the genus, that the "suggestions" presented by the example under notice do not appear to warrant any special importance being placed upon them. The colour of the spines is light green shading into light violet, and tipped with grey, and having the milled rim white or grey also. Pores arranged in arcs of four.

TEMNOPLEURUS HARDWICKII (*Gray*), *A. Agassiz*.

1855. *Toreumatica Hardwickii*, *Gray, Proc. Zool. Soc.* p. 39.

1863. *Microcyphus elegans*, *A. Agassiz, Proc. Acad. N. S. Philad.* p. 357.

1863. *Temnotrema sculpta*, A. Agassiz, *Proc. Acad. N. S. Philad.*
p. 358.

1866. *Temnopleurus japonicus*, von Martens, *Wieg. Archiv*, Jahrg. 32,
p. 133.

1872. *Temnopleurus Hardwickii*, A. Agassiz, *Rev. Echini*, pp. 166
& 460.

Coll. St. John: lat. $38^{\circ} 28' N.$, long. $141^{\circ} 25' E.$, Sendai Bay, 9 fathoms; lat. $32^{\circ} 49' N.$, long. $128^{\circ} 54' E.$, Korea (young).

In this *Temnopleurus* the sutural pits are wanting altogether on the actinal surface, whilst above the ambitus they are deep and bevelled in the median line of the interambulacral areas, but only small adjoining the poriferous zone; the sutural pits of the ambulacral areas are similar to those of the interradia, though smaller; and these broad, connected, triangular excavations give quite a naked appearance to the median line of the areas. The coronal plates carry only one large primary tubercle, which in the interambulacral areas is placed near the middle of the plate—the series forming two vertical prominent lines, which extend from the apical pole to the actinostome. The spines which are attached to these primaries are conspicuous from all the rest, both by their greater length and by their coloration, which at the base is very dark brown or purple, with the rest of the shaft pink. On either side of the interambulacral primary tubercles there is in general (except towards the apical disk) one large secondary tubercle, the remainder of the plate carrying numerous robust miliaries. In the ambulacral areas the primary tubercle is placed near the outer margin of the plate, and is accompanied by one or, near the ambitus, sometimes two secondaries and several miliaries. The anal area is small; and the genital plates are well tuberculated. The actinostome is also small in comparison with other species.

The following measurements will show the proportions:—

	A.	B.
	millim.	millim.
Diameter.....	24	27·25
Height	12	13·5
Actinostome	8	8·1

Two young specimens of this species were also obtained, and accord very closely with Mr. A. Agassiz's excellent figures of the growth stages of this *Temnopleurus*. They were dredged in

lat. $32^{\circ} 49'$ N., long. $128^{\circ} 54'$ E., and measure respectively 7 millims. and 11.2 millims. in diameter.

TEMNOPLEURUS REYNAUDI, *Agassiz* (jūv.).

1846. *Temnopleurus Reynaudi*, *Agassiz, Cat. rais., Ann. Sc. Nat.* vi. p. 360.

1855. *Toreumatica Reevesii*, *Gray, Proc. Zool. Soc.* p. 39.

— ? *Toreumatica granulosa*, *id., ibid.*

1863. *Toreumatica concava*, *A. Agassiz, Proc. Acad. N. S. Philadel.* p. 358 (*non Gray*).

1872. *Temnopleurus Reynaudi*, *A. Agassiz, Rev. Echini*, p. 166.

Coll. St. John : lat. $33^{\circ} 14'$ N., long. $182^{\circ} 55'$ E., Korea, 40 fathoms.

Very little was definitely known respecting the premature phases of *Temnopleurus* prior to the careful and characteristic drawings which Mr. Alex. Agassiz has given of this and the preceding species. The present specimens, of a diameter of 9 millims., are distinguishable from young *T. Hardwickii* of about the same size by their thinner, more compressed, and subconoid test, which is of a light ashy-grey colour, rayed with pale violet in the interambulacral areas. The apical disk is conspicuous, and the primary anal plate very large and characteristic; the ocular plates are large, with their outer margin tridentiform, and having at the base adjoining the genital plates a lozenge-shaped pit; one ocular enters the anal circle. The interambulacral sutural excavations extend up to the primary tubercle, which has the appearance of standing at the apex of a triangular depression occupying the entire adoral margin of the plate; the pits are larger and more clearly defined on the actinal than upon the abactinal surface, and those of the median ambulacral area bear on their adoral margin a very large spheridia, the series of these, which number six or seven, extending nearly up to the ambitus. There are but very few miliaries upon a plate; and the two or three which occupy the upper portion still bear traces of fine radial connexions with the primary tubercle. The secondary tubercles, of which, at the ambitus, there is one on either side of the primary, are comparatively small.

In young *T. Hardwickii* of the same size the tuberculation of the plates is distinct and more numerous, and the sutural pits, though deep, are much more limited.

TEMNOPLEURUS TOREUMATICUS (*Klein*), *Agassiz* (?) (juv.).
Pl. VIII, figs. 10, 11, 12, 13.

1734. *Cidaris toreumatica*, *Klein*, *Nat. Dispos. Echin.* p. 64.

1788. *Echinus toreumaticus*, *Gmelin*, *Linn. Syst. Nat.* 3180.

1816. *Echinus sculptus*, *Lamarck*, *Ann. sans Vert.* p. 47.

1841. *Temnopleurus toreumaticus*, *Agassiz*, *Monog. Scutelles*, p. 7; *et in Valentin*, *Anat. du gen. Echin.* p. vii.

1846. *Temnopleurus bothryoides*, *Agassiz*, *Cat. Rais.*, *Ann. Sc. Nat.* vi. p. 360 (pars).

1863. *Temnopleurus Reevesii*, *Agassiz*, *Bull. Mus. Comp. Zool. Harvard*, i. p. 23 *non* (*Gray*).

1872. *Temnopleurus toreumaticus*, *A. Agassiz*, *Revision of Echini*, p. 166.

Coll. St. John: lat. 34° 8' N., long. 126° 24' E., Korea, 24 fathoms.

A small specimen measuring 9.5 millims. in diameter, which differs entirely from the preceding young *Temnopleuri*, I refer, although not without hesitation, to the above species. The test is stout; and the primary tubercles are large and very prominent, with the sutural pits extensive and sharply defined. The well-developed secondaries and miliaries which fill the plates, form oblique lines thereon, continuous with similar lines on the companion plate, the miliaries of the upper portion of one plate following the same trend as the lower and principal range of tubercles on the accompanying plate. This feature, combined with the band-like character of the portion of the interambulacral plates which lies between the sutural cavities, is very suggestive of the arrangement in *Temnechinus*. The genital plates are comparatively large; and the anal area is surrounded by a prominent and close ring of robust secondary tubercles. Compared with young *T. Hardwickii*, the Echinoid under notice is readily distinguished from specimens of similar or even greater size by the prominent character of the tuberculation and the regularity of the special arrangement which this displays.

If the view be correct that the present premature specimen is the young of *T. toreumaticus*, the characters which it presents are such as point to an interesting phylogenetic connexion of *Temnopleurus* with *Temnechinus*; whilst it much more nearly resembles the fossil forms of that genus than the seemingly aberrant species *Temnechinus maculatus*, *A. Agassiz*.

SALMACIS SULCATA, *Agassiz*.

1846. *Salmacis sulcatus*, *Agassiz, Cat. Rais., Ann. Sc. Nat.* vi. p. 359.

— *Salmacis virgulatus*, *id., ibid.*

1850. *Melobosis mirabilis*, *Girard, Proc. Boston Soc. Nat. Hist.* iii. p. 365.

1866. *Salmacis conica*, *von Martens, Ostasiat. Echin., Wieg. Archiv, Jahrg. 32*, p. 159.

— *Diploporus pyramidata*, *Troschel, Mus. Berolin.* (fide *v. Martens*).

1866. *Salmacis pyramidata*, *v. Martens, Wieg. Archiv, Jg. 32*, p. 159 (pars).

1872. *Salmacis sulcata*, *A. Agassiz, Rev. Echin., Ill. Cat. M. C. Z. Harvard*, p. 156.

Coll. St. John: lat. $34^{\circ} 8' N.$, long. $126^{\circ} 24' E.$, Korean Straits, 24 fathoms.

Test subconoid and somewhat depressed, having small sharp triangular pores in the median areas and at the junction of the interambulacra with the poriferous zones. Ambulacral pores arranged in triple arcs, which have the appearance of forming two vertical rows, two pore-pairs standing on the inner series to one on the outer, in regular alternation—the intermediate space between these single pore-pairs being occupied by a small secondary tubercle which isolates them from one another. Coronal plates narrow, the inner third of each being naked. The interambulacral plates at the ambitus bear a horizontal row of three small tubercles, of which the middle one is the largest, and forms a vertical series extending from the apical pole to the actinostome; the series adjoining the poriferous zone diminishes very rapidly in size on the abactinal surface, becoming merely miliaries which hardly reach the apex; whilst the inner series extends only half the distance from the ambitus to the apical disk. Above these tubercles, on the upper margin of each plate, runs a horizontal row of well-spaced miliaries. The ambulacral plates carry one large tubercle closely adjoining the poriferous zone; and this at the ambitus is accompanied by another rather smaller tubercle in horizontal line, but which does not extend in vertical series to within one third of the distance of the apical disk. In addition to these primary tubercles, there are two or three miliaries on the upper margin of the plate, of which the one standing midway over the interspace between the two primaries is almost as large as a secondary tubercle, and extends in series much further towards the apical disk than the small inner primary.

The apical system is moderately large, with the anal margin closely tuberculated; the genital apertures are very large and round, and the plate bearing the madreporiform body much larger than the others; the ocular plates are stout and carry numerous tubercles, one being placed on each side of the aperture. Three specimens furnished the following measurements:—

	A. millim.	B. millim.	C. millim.
Diameter	17	14	14
Height	11·75	8·3	9·1
Actinostome	7	6	6

ECHINANTHUS TESTUDINARIUS, Gray.

1851. *Echinanthus testudinarius, Gray, Proc. Zool. Soc. Lond.* p. 35; *et Cat. Echinida* (1855), p. 6, pl. i. fig. 1.

1851. *Echinanthus australasiæ, Gray, Proc. Zool. Soc. Lond.* p. 34, *et Cat. Echinida* (1855), p. 5, pl. i. fig. 2.

1854. *Clypeaster tumidulus, Müller, Bau d. Echin.* p. 90.

1866. *Clypeaster testudinarius, v. Martens, Wiegmann Archiv, Jahrg.* 32, i. p. 170.

1870. *Clypeaster speciosus, Verrill, Silliman's Journ.* p. 95.

Coll. St. John: lat. 33° 14' N., long. 128° 55' E., west coast of Nipon, Korean Straits, 40 fathoms.

ECHINANTHUS TESTUDINARIUS, Gray.

This Clypeastroid is distinguished by the form and height of test, with its deeply impressed and gradually sloping actinal surface and large actinostome; whilst the shape of the ambulacral petals, the thickened margins of the test, and its small and widely spaced tubercles are further characteristic of the species.

The superficial resemblances which exist between certain forms of *E. testudinarius* and *Clypeaster rotundus*, A. Ag., are remarkably close; the association, however, of their comparative differences with structural characters of considerable importance is very constant, and sufficient to warrant full recognition in specific determinations.

(CLYPEASTROID) — sp. ? juv.

Coll. St. John: lat. 34° 8' N., long. 126° 24' E., Korea, 24 fathoms.

A small *Fibularia*-like Echinoid measuring 6·5 millims. in length, which is in all probability the young stage of a Clypeastroid; but to which special form it belongs it would obviously be very hazardous to determine from such limited material, in the

present state of our knowledge of the undeveloped stages of the species of that group. It is certainly different from any described *Fibularia*; but, from the characters which it presents, I prefer to regard it as a young and premature phase of growth, rather than as a new species of that very unsatisfactory genus.

ECHINOLAMPAS OVIFORMIS (*Gmel.*), *Gray.*

1788. *Echinus oviformis*, *Gmelin, Linn. Syst. Nat.* 3187.

1801. *Nucleolites oviformis*, *Lamarck, Anim. sans Vert.* p. 347.

1816. *Clypeaster oviformis*, *Lamarck, Anim. sans Vert.* p. 15.

1825. *Echinolampas oviformis*, *Gray, Ann. Phil.* x. p. 7, et *Cat. R. Echinida*, p. 35.

— *Echinolampas orientalis*, *id. ibid.*

Coll. St. John: Korean Straits, W. coast of Nipon, lat. $33^{\circ} 14' N.$, long. $128^{\circ} 55' E.$, 40 fathoms.

The *Echinolampas* referred to the above species has a very elliptical and distinctly ovoid contour when seen from above; the test is high and fully arched; apex very eccentric anteriorly, and the mouth in a somewhat more central position on the actinal surface; bourrelets moderately developed. Ambulacral petals slightly petaloid, with poriferous zones unequally developed, the anterior zones of the antero-lateral pair and the posterior zones of the postero-lateral pair being little more than half the length of the companion zone of the petal; the inner pores are round, and the outer ones somewhat larger and elongated. Tuberculation moderately distant, and widely spaced in the neighbourhood of the actinostome. Apical disk small, and the genital pores not very wide apart.

The following measurements will serve for comparison:—Length 53 millims, breadth 44 millims., height 33 millims., anterior margin to centre of apical disk 17 millims.

ECHINOCARDIUM AUSTRALE, *Gray.*

1851. *Echinocardium australe*, *Gray, Ann. & Mag. Nat. Hist.* 2nd ser. vol. vii. p. 131, et *Cat. Echinida* (1855), p. 44, pl. iv. fig. 1.

1851. *Echinocardium zealandicum*, *Gray, Ann. & Mag. Nat. Hist.* 2nd ser. vol. vii. p. 131, et *Cat. Echinida* (1855), p. 44.

1863. *Echinocardium Stimpsoni*, *A. Agassiz, Proc. Acad. N. Sc. Philadel.* p. 360.

1869. *Amphidetus novæ-zealandiæ* (*Val.*), *Perrier, Rech. s. les Pédicell.* p. 176.

Coll. St. John: lat. $33^{\circ} 10' N.$, long. $129^{\circ} 12' E.$, Korea, 36 fathoms.

Three young specimens, two of them being very small. Compared with *E. caudatum*, the abactinal surface slopes at a much smaller angle from the apical pole, whilst the contour of the test, viewed from above, is much more rotund than in similar-sized specimens of the Atlantic species. The intrapetalous fasciole forms a wider triangle outwardly; and the anal and subanal fascioles are disconnected in examples measuring only 7·2 millims. in length; whilst in *E. cordatum* of even greater size they are unmistakably confluent. The apical disk is scarcely excentral; and the peristome, though only slightly so, is more anterior than in the young of *E. cordatum*. It will be further found, when comparison is made between the two species, that relatively the periproct occupies a very high position on the posterior end in the present form, and also that the zones of the posterior lateral ambulacra converge only very slightly as they approach the ambitus, whilst in *E. cordatum* they approximate rapidly.

An example of this species of the same size as the young *E. cordatum*, given by A. Agassiz in the 'Revision of the Echini,' has been figured for the purpose of comparison (*cf.* Pl. VIII. figs. 14, 15, 16, 17).

SCHIZASTER VENTRICOSUS, *Gray*.

1851. *Schizaster ventricosus*, *Gray, Ann. & Mag. Nat. Hist.* vol. vii. p. 133.

— *Schizaster Jukesii*, *Gray, ibid.* p. 133.

1855. *Schizaster* (*Nina*) *ventricosus*, *Gray, Cat. Rec. Echinida, Brit. Mus.* p. 60, t. iv. fig. 2.

— *Schizaster* (*Nina*) *Jukesii*, *Gray, ibid.* p. 61.

1872. *Schizaster ventricosus*, *A. Agassiz, Rev. Echin. (Ill. Cat. Mus. Comp. Zool.)*, p. 158.

Coll. St. John: lat. 34° 13' N., long. 136° 73' E., 48 fathoms.

The collection contains one small specimen of this very fragile Echinoid, and measures only 14 millims. in length. Compared with *S. canaliferus*, the contour, when seen from above, is more elliptical, the test being much fuller and more rotund in the posterior portion, and having its greatest breadth across the hinder third; the apex is not so eccentric; and the present *Schizaster* is further characterized by the great height of the posterior portion of the test; a rapid slope to the actinal surface forms the truncate anal end, the upper part of which does not overhang the lower, the periproctal orifice being situated very high up on the area. The odd anterior ambulacrum is not so wide as in *S. cana-*

liferus; and the lateral keels which bound it are more strongly developed. The anterior lateral ambulacra are very broad, whilst the posterior petals are shorter, more pear-shaped, and have a concave curve outwardly.

Conclusion.

The following list will indicate the extremes, as at present known, of the geographical distribution of the species comprised in the above collection:—

ASTEROIDEA.

- Astropecten formosus*, mihi Korea.
 — *japonicus*, M. & T. Japan.
 — *polyacanthus*, M. & T. Red Sea, Zanzibar, Australia, Fiji Islands, Japan.
Stellaster Belcheri, Gray New Guinea, N. Australia.
Cribrella densispina, mihi Korea.
Asteracanthion rubens, Linné Japan, N. Atlantic.

ECHINOIDEA.

- Strongylocentrotus intermedius* Seghalion, Japan, Australia.
 (Barn.), A. Ag.
Echinometra lucunter (Leske), Bl. Red Sea, Indian Ocean, Society Islands, Sandwich Islands, Japan.
Temnopleurus Hardwickii (Gray), Japan, Unalaska (*Dall, Smithsonian coll.*).
 A. Ag.
 — *Reynaudi*, Ag. Ceylon, Malacca, N. China seas.
 — *toreumaticus* (Klein), Ag. Persian Gulf, Siam, Philippine Islands, N. China seas.
Salmacis sulcata, Ag. Red Sea, Indian Ocean, Australia, China.
Echinanthus testudinarius, Gray Red Sea, Australia, Japan, Sandwich Islands, California.
Echinolampas oviformis (Gmel.), Red Sea, Cape of Good Hope, Gray. Molucca.
Echinocardium australe, Gray South Africa, New Zealand, Australia, China, S. Japan.
Schizaster ventricosus, Gray Siam, Hongkong, Fiji Islands*.

An analysis of the above will show that, out of the six Asteroids, three are additions to the fauna of Japan, viz. *Astropecten formosus*, *Stellaster Belcheri*, and *Cribrella densispina*. Of these, *Stellaster Belcheri* has hitherto been known as inhabiting N. Australia and New Guinea only; *Astropecten formosus* may be regarded as

* In drawing up this list, I am indebted for a number of citations of collection to Mr. Alexander Agassiz's "Revision of the Echini," Ill. Cat. Mus. Comp. Zool. Harvard, vii. 1872-74.

a representative form of the N.-Atlantic *A. irregularis* type; and *Cribrella densispina* I am disposed to consider an independent development from *C. sanguinolenta* of the N. Atlantic. Of the remaining Starfish, *Asteracanthion rubens* is the widely spread Atlantic and circumpolar Asteroid; *Astropecten japonicus* is confined to Japanese waters; and *Astr. polyacanthus* has a very extensive distribution, extending from the Red Sea on the west to the Fiji Islands on the east, and reaching northward to Japan—the most important feature which is thus rendered prominent being the presence of northern or representative northern species of Starfish in the Korean seas.

Turning now to the Echinoidea, it will be found that, of the ten which have been enumerated above, five are additions to the Japanese fauna, viz. *Temnopleurus Reynaudi*, *T. toreumaticus*, *Salmacis sulcata*, *Echinolampas oviformis*, and *Schizaster ventricosus*. Of these, *Temnopleurus Reynaudi* has hitherto been ranked as a more southern form, and having an extension westward as far as Ceylon; and similarly *T. toreumaticus*, which has a still greater westerly stretch to the Persian Gulf. *Salmacis sulcata* is likewise a more southern species, and with a distribution westward as far as the Red Sea; *Echinolampas oviformis* is quite a western form in relation to Japan; and *Schizaster ventricosus* occupies a southern area which ranges eastward to the Fiji Islands. Of the remaining five, which are known Japanese forms, two have a very wide distribution, viz. *Echinometra lucunter* and *Echinanthus testudinarius*, the former extending from the Red Sea to Australia and thence eastward to the Society Islands, and the latter occupying nearly the same area, but with a still greater easterly extension, reaching to California; *Echinocardium australe* extends southward to New Zealand and westward to South Africa,—none of the Echinoids above mentioned having a more northerly extension than some portion of the Japan islands. *Strongylocentrotus intermedius* reaches from Seghalion to Australia; and *Temnopleurus Hardwickii* is the only one whose limits extend no further southwards than Japan, whilst it reaches a latitude as far north as Unalaska.

From this conspectus it will be seen that all the Echinoidea, with the exception of a single instance, are those occupying a habitat which has a more southern and, in general, also a more westerly extension than the locality under notice.

It is especially noteworthy in this collection of specimens from

the Korean Seas, that whilst a large proportion of the Asteroids point to a northern centre of derivation, the Echinoidea, on the other hand, all belong to species having a southern and westward area of distribution.

DESCRIPTION OF PLATE VIII.

- Fig. 1. *Astropecten formosus*. Abactinal aspect, natural size.
2. Actinal side of same specimen, about the middle of a ray, $\times 10$.
 3. Arrangement of the foot-papillæ on the inner portion of the ambulacral furrow, $\times 10$.
 4. Abactinal side of same specimen, about the middle of a ray, $\times 10$.
 5. *Cribrella densispina*. Abactinal aspect, natural size.
 6. Actinal side of same specimen, about the middle of a ray, $\times 10$.
 7. Arrangement of the foot-papillæ, seen somewhat obliquely, and more highly magnified.
 8. Abactinal side of same specimen, about the middle of a ray, $\times 10$.
 9. Madreporiform body of same specimen, $\times 10$.
 10. *Temnopleurus torcumaticus* (Klein), Ag. (?), juv. ; profile, natural size.
 11. Actinal aspect of same specimen, natural size.
 12. Portion of test of same specimen, $\times 10$.
 13. Apical disk of same specimen, $\times 10$.
 14. *Echinocardium australe*, Gray. A young specimen 7.75 millims. in length ; abactinal aspect, $\times 5$.
 15. Actinal aspect of same specimen, $\times 5$.
 16. Longitudinal profile of same specimen, $\times 5$.
 17. Portion of the posterior end of the test of same specimen, showing the separation of anal and subanal fascioles, magnified.

ON some Ophiuroidea from the Korean Seas. By Professor P. MARTIN DUNCAN, M.B. (Lond.), F.R.S., &c. (Communicated by W. PERCY SLADEN, Esq., F.L.S.)

[Read June 6, 1878.]

(PLATES IX.-XI.)

- I. Introduction and General Relations of the Fauna.
- II. List of Families, Genera, and Species.
- III. Description of the New Species, and notices of those hitherto known.
- IV. Remarks on the Species, and on their Affinities. ;
- V. Description of the Plates.

I. *Introduction and Relations of the Fauna.*

CAPT. St. John, R.N., in his late voyage in and about the seas to

